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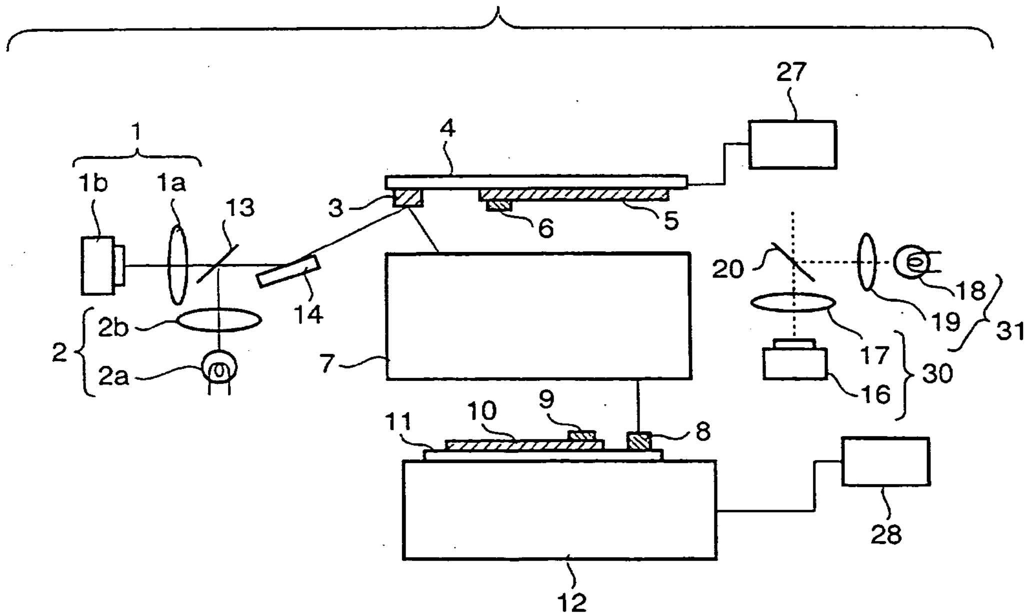
(54) **Position detection method and apparatus**

(57) A reticle stage reference mark 3 of material having high reflectivity to alignment illumination light is provided on a reticle 5, and a chuck mark 8 of material having high reflectivity to the alignment illumination light is provided on a wafer chuck 11. A relative position of the reticle stage reference mark 3 to the chuck mark 8 is detected by using a first position detection optical system 1 and a first illumination optical system 2, and relative alignment is performed between the reticle 5 and a wafer 10.

FIG. 1



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Description

FIELD OF THE INVENTION

[0001] The present invention relates to position detection method and apparatus appropriate for exposure apparatus and exposure method for transfer of fine circuit pattern. More particularly, the present invention is preferably applicable to alignment of substrate such as a wafer in an exposure apparatus using extreme ultraviolet light (EUV light).

BACKGROUND OF THE INVENTION

[0002] Conventionally, as a lithography for fabrication of fine semiconductor such as a semiconductor memory or a logic circuit, projection reduction exposure using ultraviolet light has been employed.

[0003] The minimum size which can be transferred by the projection reduction exposure is proportional to the wavelength of light of the transfer, and unproportional to numerical aperture of projection optical system. Accordingly, to transfer a fine circuit pattern, light of short wavelength such as mercury lamp i ray (wavelength: 365 nm), KrF excimer laser (wavelength: 248 nm), ArF excimer laser (wavelength: 193 nm) are employed. Thus the wavelength of ultraviolet light has been shortened.

[0004] However, as finer semiconductor devices are rapidly developed, transfer of such finer devices cannot be handled without difficulty in the lithography using ultraviolet light. Accordingly, to efficiently print a very fine circuit pattern less than 1 μm, a projection reduction exposure apparatus using extreme ultraviolet light (EUV light) having a wavelength of 10 to 15 nm which is further shorter than that of the ultraviolet ray has been developed.

[0005] In an EUV light area, as the amount of absorption by material is very large, a lens optical system utilizing light refraction which is used for visible and ultraviolet light, is impractical. Accordingly, in the exposure apparatus using EUV light employs a reflection optical system. In this case, a reflective type reticle where a pattern to be transferred is formed by light absorbing material on a mirror is employed as a plate.

[0006] As a reflection optical device constructing the EUV exposure apparatus, a multilayer mirror and an oblique incidence total reflection mirror are known. In the EUV area, as the real part of the refractive index is slightly less than 1, total reflection occurs by using EUV light as oblique incidence as closely to the surface as possible. Generally, in oblique incidence within several degrees from the surface, a high reflectivity of several tens % or higher can be obtained. However, as the freedom of optical design is limited, it is difficult to use the total reflection mirror in the projection optical system.

[0007] The mirror for the EUV light used at an incident angle close to direct incidence is a multilayer mirror where two types of materials having different optical constants are alternately laminated. For example, molybdenum and silicon are alternately laminated on the surface of a glass substrate which is ground to have a precise surface shape. The thickness of the molybdenum layer is, e.g., 0.2 nm, that of the silicon layer, e.g., 0.5 nm, and the number of layers is about 20 pairs. The sum of the thicknesses of the two types of layers is called a film period. In the above example, as the film period, 0.2 nm + 0.5 nm = 0.7 nm holds.

[0008] When the EUV light is incident on the multilayer mirror, EUV light of particular wavelength is reflected. Assuming that the incident angle is θ, the EUV light wavelength, λ, and the film period, d, only narrow band EUV light, mainly having the wavelength λ approximately satisfying the relation by Bragg's equation

$$2 \times d \times \sin\theta = \lambda$$

is efficiently reflected. The bandwidth at this time is about 0.6 to 1 nm.

[0009] The reflectivity of the reflected EUV light is about 0.7 at the maximum. EUV light which has not been reflected is absorbed in the multilayer or the substrate, and most of the energy of the light becomes heat.

[0010] As light loss of the multilayer mirror is greater in comparison with a visible light mirror, the number of mirrors must be a minimum number. To realize a wide exposure area with a small number of mirrors, employed is a method for transfer (scan exposure) in a wide area by simultaneously scanning a reticle and a wafer using only a slim ring area (ring field) away from an optical axis by a predetermined distance.

[0011] Fig. 6 is a schematic diagram of the conventional projection reduction exposure apparatus using EUV light. The exposure apparatus comprises an EUV light source 50, an illumination optical system 60, a reflective type reticle 81, a projection optical system 70, a reticle stage 80, a wafer stage 85, an off-axis alignment optical system (detection mechanism) 90, a vacuum system and the like.

[0012] As the EUV light source 50 is, e.g. a laser plasma light source. Light from a high-intensity pulse laser 53 is gathered by a light gathering lens 54, emitted on a target material placed in a vacuum container 52 supplied from a target supply device 51, to cause high temperature plasma 55, and EUV light having a wavelength of e.g. about 13 nm, radiated from the plasma is utilized. As the target material, a metal thin film, inertia gas, a liquid drop or the like is used. The target material is supplied by gas jet means or the like into the vacuum container 52. To increase the mean intensity of the radiated EUV light, it is preferable that the repetition frequency of the pulse laser 53 is high. Generally, the pulse laser is operated by a several kHz repetition frequency.

[0013] The illumination optical system 60 comprises plural multilayer or oblique incidence first to third mirrors 61 to 63, an optical integrator 64 and the like. The first-

stage light gathering mirror 61 corrects EUV light approximately isotropically radiated from the laser plasma 53. The optical integrator 64 uniformly illuminates a mask with an a predetermined numerical aperture. Further, an aperture 65 to limit an illuminated area of the reticle surface to a circular shape is provided in the position of the illumination optical system 60 conjugate with the reticle 81.

[0014] The projection optical system 70 uses plural mirrors 71 to 74. As the number of mirrors is small, the efficiency of use of EUV light is high, however, the aberration cannot be easily corrected. The number of mirrors necessary for aberration correction is about 4 to 6. The shape of the mirror reflection surface is spherical surface such as convex or concave surface or an aspherical surface. The numerical aperture NA is about 0.1 to 0.3.

[0015] The mirror is obtained by grinding and polishing a substrate of material having a high rigidity and hardness and a low thermal expansion rate, such as low-expansion glass or silicon carbide, to form a predetermined reflection surface shape, then forming a multilayer film of molybdenum, silicone and the like on the reflection surface. If the incident angle is not constant depending on a position within the mirror surface, as it is apparent from the above-described Bragg's equation, the wavelength of EUV light having the reflectivity, which increases depending on position of multilayer film having a constant film period, is shifted. Accordingly, the mirror surface must have a film period distribution to attain efficient reflection of the EUV Light of the same wavelength within the mirror surface.

[0016] The reticle stage 80 and the wafer stage 85 have a mechanism to scan in synchronization with each other at a speed rate proportional to a reduction scaling factor. In the reticle 81 or the wafer 86 surface, a scanning direction is X, a direction normal to the scanning direction is Y, and a direction normal to the reticle 81 or the wafer 86 surface is Z.

[0017] The reticle 81 is held on a reticle chuck 82 on the reticle stage 80. The reticle stage 80 has a mechanism to move in the direction X at a high speed. Further, the reticle stage has a mechanism to slightly move in the directions X, Y and Z and rotational directions about the respective axes for positioning of the reticle 81. The position and posture of the reticle stage 80 is measured by a laser interferometer, and the position and the posture are controlled in accordance with the result of measurement.

[0018] The wafer 86 is held on the wafer stage 85 by the wafer chuck 88. The wafer stage 85 has a mechanism similar to that of the reticle stage 80 to move in the direction X at a high speed. Further, the wafer stage has a mechanism to slightly move in the directions X, Y and Z and rotational directions about the respective axes for positioning of the wafer. The position and posture of the wafer stage 85 is measured by a laser interferometer, and the position and the posture are controlled in accordance with the result of measurement.

[0019] The alignment detection mechanism 90, as in the case of e.g. an ArF exposure apparatus, performs wafer alignment by an off-axis bright field illumination image processing detection system while holding a predetermined baseline amount.

[0020] Further, a focus position in the direction Z is measured by a focus position detection mechanism 91, and the position and angle of the wafer stage 85 are controlled, thereby the wafer surface is held in a image-formation position by the projection optical system 70 during exposure.

[0021] When 1 scan exposure has been completed on the wafer 86, the wafer stage 85 step-moves in the directions X and Y to the next scan exposure start position. Again the reticle stage 80 and the wafer stage 85 scan in synchronization with each other in the direction X at the speed rate proportional to the reduction scaling factor of the projection optical system 70.

[0022] In this manner, the synchronized scanning in the status where a reduced projection image of the reticle 81 is formed on the wafer 86 is repeated (step and scan). Thus the transfer pattern of the reticle 81 is transferred onto the entire surface of the wafer 86.

[0023] The off-axis bright field illumination image processing detection system is used as the alignment detection mechanism as in the case of the ArF exposure apparatus, however, to address a requirement for finer semiconductor devices, alignment in higher precision must be realized. Accordingly, the stability of the base line is required equally or more in comparison with the ArF exposure apparatus.

[0024] However, in the EUV exposure apparatus, a measurement system to automatically measure the baseline, especially means for measuring the reticle and wafer or the like has not been proposed.

[0025] The automatic measuring system have not been proposed since a relative positional alignment (hereinbelow referred to as "TTL (Through The Lens) alignment") between the reticle and the wafer via the projection optical system has the following problems.

[0026] In a case where the TTL alignment is performed in the EUV exposure apparatus, illumination light to detect an alignment mark (e.g. as the used wavelength is not EUV, it is a non exposure light) is reflected from the reflective type reticle and passed through the multilayer mirror optical system. The light illuminates a wafer alignment mark on the wafer, then reflected light from the wafer alignment mark is again passed through the multilayer mirror optical system and the reflective type reticle. Then the alignment mark is detected by the alignment detection optical system having an image formation optical system and an image sensing device.

[0027] In this manner, if the TTL alignment is performed by the non-exposure light via the reflective type reticle and the multilayer mirror, as the reflective type reticle and the multilayer mirror are optimized to attain a high reflectivity by the EUV light, a sufficient reflectivity

cannot be attained by the non-exposure illumination light. Accordingly, there is a possibility that high precision alignment cannot be performed.

[0028] Further, in case of off-axis method, the stability of baseline is required. To attain the stability of baseline, it is necessary to use material having high mechanical rigidity and low thermal sensitivity and to attain ultra stable heat distribution, which increase the cost of the apparatus.

SUMMARY OF THE INVENTION

[0029] Embodiments of the present invention may enable high-precision alignment between a plate such as a reticle and a substrate such as a wafer without expensive part.

[0030] In an embodiment, there is provided a position detection method for detecting positions of a reflective type plate and a substrate upon exposure-transfer of pattern on the plate onto the substrate by emitting non-exposure light to the plate and the substrate and receiving reflected light from the plate and the substrate, comprising: a first position detection step of detecting a plate holding unit mark, being provided on a plate holding unit movable while holding the plate and having a predetermined reflection characteristic to the non-exposure light, and a substrate holding unit mark, being provided on a substrate holding unit movable while holding the substrate and having a predetermined reflection characteristic to the non-exposure light; and a relative position detection step of detecting a relative position of the plate to the substrate from relative position of the plate holding unit mark to the substrate holding unit mark.

[0031] Further, preferably, a plate alignment mark is provided on the plate, and the method further comprises a second position detection step of detecting a relative position of the plate holding unit mark to the plate alignment mark.

[0032] Further, preferably, a substrate alignment mark is provided on the substrate, and the method further comprises a third position detection step of detecting a relative position of the substrate holding unit mark to the substrate alignment mark.

[0033] Further, preferably, at the first position detection step, the substrate holding unit mark is detected on-axis in the same position as an exposure position, and at the relative position detection step, relative alignment is made between the plate and the substrate by using positional information of the substrate holding unit mark.

[0034] Further, preferably, the non-exposure light is extreme ultra violet light having a wavelength of 10 to 15 nm, and wherein the predetermined reflection characteristic is a reflectivity to the non-exposure light set to 95% or higher.

[0035] Further, preferably, the reflective type plate has a reflection portion of multilayer structure.

[0036] Further, preferably, the substrate holding unit has a substrate chuck holding the substrate, and wherein the substrate holding unit mark is provided on the substrate chuck.

[0037] Further, preferably, at the first position detection step, the plate holding unit mark and the substrate holding unit mark are detected upon each exposure.

[0038] Further, provided is a position detection apparatus for detecting positions of reflective type plate and a substrate upon exposure-transfer of pattern on the plate onto the substrate by emitting non-exposure light to the plate and the substrate and receiving reflected light from the plate and the substrate, comprising: a first position detection unit that detects a plate holding unit mark, being provided on a plate holding unit movable while holding the plate and having a predetermined reflection characteristic to the non-exposure light, and a substrate holding unit mark, being provided on a substrate holding unit movable while holding the substrate and having a predetermined reflection characteristic to the non-exposure light; and a relative position detection unit that detects a relative position of the plate to the substrate from relative position of the plate holding unit mark to the substrate holding unit mark.

[0039] Further, preferably, a plate alignment mark is provided on the plate, and the apparatus further comprises a second position detection unit that detects a relative position of the plate holding unit mark to the plate alignment mark.

[0040] Further, preferably, a substrate alignment mark is provided on the substrate, and the apparatus further comprises a third position detection unit that detects a relative position of the substrate holding unit mark to the substrate alignment mark.

[0041] Further, preferably, the first position detection units detects the substrate holding unit mark on-axis in the same position as an exposure position, and the relative position detection unit performs relative alignment between the plate and the substrate by using positional information of the substrate holding unit mark.

[0042] Further, preferably, the non-exposure light is extreme ultra violet light having a wavelength of 10 to 15 nm, and the predetermined reflection characteristic is reflectivity to the non-exposure light set to 95% or higher.

[0043] Further, preferably, the reflective type plate has a reflection portion of multilayer structure.

[0044] Further, preferably, the substrate holding unit has a substrate chuck holding the substrate, and the substrate holding unit mark is provided on the substrate chuck.

[0045] Further, preferably, the first position detection unit detects the plate holding unit mark and the substrate holding unit mark upon each exposure.

[0046] Further, provided is an exposure method for performing alignment between a plate and a substrate based on the relative position of the plate to the substrate detected by any one of the above position detection methods, and exposure-transferring a pattern on the plate onto the substrate.

[0047] Further, provided is an exposure apparatus comprising: the position detection apparatus according to any one of the above position detection methods; a moving control unit that performs alignment between the plate and the substrate by move-controlling the plate holding unit and the substrate holding unit based on a relative position of the plate to the substrate detected by the position detection apparatus; and an exposure control unit that exposure-transfers the pattern on the plate onto the substrate in a status where the plate and the substrate are aligned with each other.

[0048] More specifically, an embodiment proposes a method for enabling high precision alignment independent of baseline stability by attaining high precision by using high alignment illumination light for TTL alignment. The TTL alignment is made between a reticle stage reference mark and a chuck mark. The reticle stage reference mark is formed on the reticle stage. The reticle stage reference mark has sufficiently high reflectivity of 95% or higher to the alignment illumination light. The relative position of the reticle to the reticle stage reference mark is ensured by the precision of reticle stage drive.

[0049] The chuck mark is formed on the chuck to hold the wafer on the wafer stage. The chuck mark has sufficiently high reflectivity of 95% or higher to the alignment illumination light. The relative position of the wafer to the chuck mark is ensured by the precision of wafer stage drive for wafer exposure or another stage drive.

[0050] In this manner, the TTL alignment is performed by using the reticle stage reference mark in place of the reticle. Accordingly, as the light quantity of the alignment illumination light is not reduced and the chuck mark is detected by the TTL alignment system, high precision alignment without baseline is realized.

[0051] In a general projection exposure apparatus, alignment between a reticle and a wafer via a projection lens is called TTL alignment, however, in the EUV exposure apparatus, as the projection optical system comprises a multilayer mirror optical system in place of the lens, alignment there cannot be called TTL alignment. However, in the present specification, the alignment via the multilayer mirror optical system is also defined as TTL alignment for the sake of simplicity of explanation.

[0052] The present invention is further applicable to a semiconductor device fabrication method comprising: a step of installing a fabrication apparatus group for various processes including the above-mentioned exposure apparatus in a semiconductor fabrication factory; and a step of fabricating a semiconductor device by plural processes by using the fabrication apparatus group. It is preferable that the method further comprising: a step of connecting the fabrication apparatus group by a local area network; and a step of performing data communication for transmission of information on at least one apparatus of the fabrication apparatus group between the local area network and an external network outside the semiconductor fabrication factory. In this case, maintenance information for the fabrication apparatus is obtained by accessing a database provided by a vendor or a user of the exposure apparatus via the external network, or production management is performed by data communication with other semiconductor fabrication factory than the semiconductor fabrication factory via the external network.

[0053] The present invention is further applicable to a semiconductor fabrication factory having: a fabrication apparatus group including the above exposure apparatus; a local area network connected to the fabrication apparatus group; and a gateway that enables access from the local area network to an external network outside the factory, wherein data communication is performed for transmission of information on at least one apparatus of the fabrication apparatus group.

[0054] Further, the present invention is applicable to a exposure apparatus maintenance method for maintenance of the above-mentioned exposure apparatus installed in a semiconductor fabrication factory, comprising: a step of providing a maintenance database connected to an external network outside the semiconductor fabrication factory by a vendor or user of said exposure apparatus; a step of permitting access to said maintenance database from said semiconductor fabrication factory via said external network; and a step of transmitting maintenance information stored in said maintenance database to the side of said semiconductor fabrication factory via said external network.

[0055] Further, it may be arranged such that the exposure apparatus further comprises a display, a network interface and a computer that executes network software, wherein maintenance information for the exposure apparatus is transmitted via a computer network. Further, it is preferable that the network software provides a user interface on the display to access a maintenance database, provided by a vendor or user of the exposure apparatus, connected to an external network outside the factory having the exposure apparatus, and obtains information from the database via the external network.

[0056] Other objects and advantages besides those discussed above shall be apparent to those skilled in the art from the description of a preferred embodiment of the invention which follows. In the description, reference is made to accompanying drawings, which form a part thereof, and which illustrate an example of the invention. Such example, however, is not exhaustive of the various embodiments of the invention,

BRIEF DESCRIPTION OF THE DRAWINGS

[0057] The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

Fig. 1 is a schematic cross-sectional view of a position detection apparatus according to an embodiment of the present invention;
Fig. 2 is a schematic cross-sectional view showing detection of a reticle alignment mark on a reticle in the embodiment;
Fig. 3 is a schematic cross-sectional view showing detection of a reticle stage reference mark on a reticle stage in the embodiment;
Fig. 4 is a schematic cross-sectional view showing detection of a chuck mark on a wafer chuck on a wafer stage in the embodiment;
Fig. 5 is a schematic cross-sectional view showing detection of a wafer alignment mark on a wafer in the embodiment;
Fig. 6 is a schematic cross-sectional view of a position detection apparatus of the conventional art;
Fig. 7 is a conceptual diagram of a semiconductor device production system using the apparatus according to the embodiment, viewed from an angle;
Fig. 8 is a conceptual diagram of the semiconductor device production system using the apparatus according to the embodiment, viewed from another angle;
Fig. 9 is a particular example of user interface;
Fig. 10 is a flowchart showing device fabrication process; and
Fig. 11 is a flowchart showing a wafer process.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0058] Preferred embodiments where the position detection method and apparatus of the present invention are applied to a semiconductor exposure apparatus will now be described in detail in accordance with the accompanying drawings.

[0059] Figs. 1 to 5 are schematic cross-sectional views showing a semiconductor exposure apparatus including a position detection apparatus according to an embodiment of the present invention and a mark detection status.

[0060] In Figs. 1 to 5, the exposure apparatus of the present embodiment has first position detection optical system 1 and first illumination optical system 2 (first position detection step, unit), second position detection optical system 30 and second position illumination optical system 31 (second position detection process, unit), third position detection optical system 40 and third illumination optical system 41 (third position detection step, unit), a moving stage 26 which moves a wafer chuck 11, holding a wafer 10 as a plate, to the third position detection optical system 40, a reticle stage 4 which is move-controlled while holding the reticle 5 as a reflective type plate, having a multilayer reflection portion, a multilayer mirror optical system 7, a wafer chuck 11 holding a wafer 10, and a wafer stage 12 which is move-controlled while carrying the wafer chuck 11 holding the wafer 10.

[0061] The reticle stage 4, the wafer stage 12 and the moving stage 26 are move-controlled by a stage controller (not shown) upon position detection of respective marks, alignment between the reticle 5 and the wafer 10 or exposure, to be described later.

[0062] The first position detection optical system 1 has an image sensing device 1a such as a CCD and an image formation optical system 1b, and the first illumination optical system 2 has a light source 2a to emit non-exposure light and a light gathering lens 2b. The second position detection optical system 30 has an image sensing device 16 such as a CCD and an image formation optical system 17, and the second illumination optical system 31 has a light source 18 to emit exposure light and a light gathering lens 19. The third position detection optical system 40 has an image sensing device 24 such as a CCD and an image formation optical system 25, and the third illumination optical system 41 has a light source 21 to emit exposure light and a light gathering lens 22.

[0063] Illumination light from the first illumination optical system 2 is reflected by a half mirror 13 and a mirror 14, and illuminates a reflective type alignment mark (hereinbelow referred to as a "reticle stage reference mark") 3 provided on the reticle stage 4. Further, the illumination light reflected from the reticle stage reference mark 3 passes through the multilayer mirror optical system 7, and illuminates a chuck mark 8 on the wafer chuck 11 holding the wafer 10 as a substrate.

[0064] Further, illumination light from the second illumination optical system 31 is reflected by a half mirror 20, and illuminates the reticle stage reference mark 3 and the reticle alignment mark 6 on the reticle stage 4. Further, the illumination light reflected from the reticle stage reference mark 3 or the reticle alignment mark 6 passes through the half mirror 20, and received by the image sensing device 16 and the image formation optical system 17.

[0065] Further, illumination light from the third illumination optical system 41 is reflected by a half mirror 23, and illuminates a reflective type chuck mark 8 provided on the wafer chuck 11 and a wafer alignment mark 9 provided on the wafer 10. Further, the illumination light reflected from the chuck mark 8 or the wafer alignment mark 9 passes through the half mirror 23, and received by the image sensing device 24 and the image formation optical system 25.

[0066] The relative positional alignment between the reticle stage reference mark 3 and the chuck mark 8 is performed by detecting images of the reticle stage reference mark 3 and the chuck mark 8 illuminated by the first illumination optical system 2, calculating the relative position of the reticle stage reference mark 3 to the chuck mark 8 from positional information obtained by image processing in an positional information calculation unit (not shown) (relative position detection step, unit), and using the calculated relative positional infor-

mation.

[0067] Further, the positional information calculation unit obtains positional information of the respective marks by performing image processing on the image of the mark detected by the second position detection optical system 30 and the second illumination optical system 31 and the image of the mark detected by the third position detection optical system 40 and the third illumination optical system 41, as well as the image of the mark detected by the first position detection optical system 1 and the first illumination optical system 2.

[0068] The reticle stage reference mark 3 comprises a member having sufficiently high reflectivity of 95% or higher as reflection characteristic to the non-exposure alignment illumination light. The relative position of the reticle 4 to the reticle stage reference mark 3 is ensured by the precision of drive of the reticle stage drive 4.

[0069] Similarly, the chuck mark 8 comprises a member having sufficiently high reflectivity of 95% or higher as reflection characteristic to the non-exposure alignment illumination light. The relative position of the wafer 10 to the chuck mark 8 is ensured by the precision of drive for wafer exposure or another wafer stage.

[0070] In this manner, the TTL alignment is performed by using the reticle stage reference mark in place of reticle. As the light quantity of the alignment illumination light is not reduced and the chuck mark is detected by the TTL alignment system, high precision alignment without baseline is realized.

[0071] The relative position of the reticle stage reference mark 3 to the reticle alignment mark 6 is detected in advance by a method to be described with reference to Figs. 2 and 3. Further, the relative position of the chuck mark 8 to the wafer alignment mark 9 is detected in advance by a method to be described with reference to Figs. 4 and 5.

[0072] In this manner, as the relative position of the reticle stage reference mark 3 to the reticle alignment mark 6, and the relative position of the chuck mark 8 to the wafer alignment mark 9, are detected in advance, relative alignment between the reticle 5 and the wafer 10 can be made by determining relative position of the reticle stage reference mark 3 to the chuck mark 8.

[0073] First, the method for previously determining the relative position of the reticle alignment mark 6 to the reticle stage reference mark 3 will be described with reference to Figs. 2 and 3.

[0074] Fig. 2 shows the method for detecting the relative position of the reticle stage reference mark 3 provided on the reticle stage 4 to the reticle alignment mark 6 provided on the reticle 5. In the figure, the reticle alignment mark 6 on the reticle 5 is detected. In comparison with Fig. 1, the reticle 5 and the reticle stage reference mark 3 move by the drive by the reticle stage 4, and the image of the reticle alignment mark 6 is received by the image sensing device 16 of the second position detection optical system 30.

[0075] Fig. 3 shows the method for detecting the relative position of the reticle stage reference mark 3 provided on the reticle stage 4 to the reticle alignment mark 6 provided on the reticle 5. In the figure, the reticle stage reference mark 3 on the reticle stage 4 is detected. In Fig. 3, in comparison with Figs. 1 and 2, the drive by the reticle stage 4 is further made in an arrow direction, the reticle 5 and the reticle stage reference mark 3 further move, and the image of the reticle stage reference mark 3 is received by the image sensing device 16 of the second position detection optical system 30.

[0076] An example of the detection sequence will be described. First, the reticle stage 4 is moved in the status of Fig. 2, the reticle alignment mark 6 is moved to a mark detection position of the second position detection optical system 30, reflected light from illumination light of the second illumination optical system 31 is received by the second position detection optical system 30, the position of the reticle alignment mark 6 on the reticle 5 is detected by image processing, and the position of the reticle stage 4 at that time is stored into a reticle stage position storage device 27.

[0077] Next, the reticle stage 4 is moved to the status in Fig. 3, the reticle stage reference mark 3 is moved to the mark detection position of the second position detection optical system 30, the reflected light from illumination light of the second position detection optical system 31 is received by the second position detection optical system 30, the position of the reticle stage reference mark 3 on the reticle stage 4 is detected by image processing, and the position of the reticle stage 4 at that time is stored into the reticle stage position storage device 27.

[0078] Then, the relative position of the reticle stage reference mark 3 to the reticle alignment mark 6 is detected from the positional information of the reticle stage 4 upon detection of the respective marks detected by the second position detection optical system 30.

[0079] Note that the second position detection optical system 30, the second illumination optical system 31 and the half mirror 20 may have a moving-controllable mechanism.

[0080] Further, upon detection of the relative position of the reticle stage reference mark 3 to the reticle alignment mark 6, the heights of the two marks may be detected by detection of defocus characteristics of the obtained images.

[0081] Next, the method for detecting the relative position of the chuck mark 8 to the wafer alignment mark 9 will be described with reference to Figs. 4 and 5.

[0082] Figs. 4 and 5 show detection of the respective positions of the chuck mark 8 provided on the wafer chuck 11 provided on the wafer stage 12 and the wafer alignment mark 9 provided on the wafer 10, and the relative position of the chuck mark 8 to the wafer alignment mark 9.

[0083] Similarly to the second position detection optical system 30, the third position detection optical system 40 detects the positions of the marks 8 and 9 by receiv-

ing images of the respective marks and performing image processing on the received images, and detects the relative position of the chuck mark 8 to the wafer alignment mark 9 from these respective positional information.

[0084] First, the moving stage 26 carrying the chuck 11 is moved to the status in Fig. 4, plural (only one is shown in Fig. 4) chuck marks 8 provided on the chuck 11 are moved to the mark detection position of the third position detection optical system 40, reflected light from the illumination light of the third illumination optical system 41 is received by the third position detection optical system 40, the positions of the respective chuck marks 8 on the chuck 11 are detected by image processing, and the position of the moving stage 26 at that time is stored into a moving stage position storage device 29.

[0085] Next, the moving stage 26 is further moved to the status in Fig. 5, plural (only one is shown in Fig. 5) wafer alignment mark 9 corresponding to plural exposure shots provided on the wafer 10 held on the chuck 11 are moved to the mark detection position of the third position detection optical system 40, the reflected light from the illumination light of the third illumination optical system 41 is received by the third position detection optical system 40, the positions of the respective wafer alignment marks 9 on the wafer 10 are detected by image processing, and the position of the moving stage 26 at that time is stored into the moving stage position storage device 29.

[0086] Then, the relative position of the chuck mark 8 to the wafer alignment mark 9 is detected from the positional information of the moving stage 26 upon detection of the respective marks detected by the third position detection optical system 40.

[0087] By the above procedure, the position of the reticle alignment mark 6, upon detection of the relative position of the reticle 5 to the wafer 10, can be detected by using the positional information of the reticle stage reference mark 3 detected on-axis in the same position of that of the exposure position. Similarly, the position of the wafer alignment mark 9 can be detected by using the positional information of the chuck mark 8 detected on-axis in the same position of the exposure position via the multilayer mirror 7. The chuck mark 8 can be set in an arbitrary position on the chuck 11, further, a wafer to obtain high reflectivity to the illumination light can be selected. Thus the freedom of design can be improved.

[0088] Further, when the relative position of the chuck mark 8 to the wafer alignment mark 9 is detected, the heights of the two marks can be detected by detection of defocus characteristics of the obtained images.

[0089] Next, a method for detecting the relative position of the reticle stage reference mark 3 to the chuck mark 8 and performing alignment therebetween, and performing exposure will be described. Note that general alignment and exposure are disclosed by e.g. Japanese Patent Application Laid-Open No. 61-263127.

[0090] More particularly, before the pattern of the reticle 5 is exposure-transferred to the wafer 10, the relative position of the reticle stage reference mark 3 to the reticle alignment mark 6, and the relative position of the chuck mark 8 to the wafer alignment mark 9 are detected in advance, as described above; thereafter, the chuck 11 and the wafer 10 are conveyed onto the wafer stage 12 while the wafer 10 is held on the chuck 11 where the chuck mark 8 is provided.

[0091] Next, the reticle stage 4 and the wafer stage 12 are driven, thereby the reticle 5 and the wafer 10 are moved to the exposure position from the relative positions of the respective marks.

[0092] Then, the relative position of the reticle stage reference mark 3 provided on the reticle 5 to the chuck mark 8 is detected by the first position detection optical system 1 and the first illumination optical system 2 on-axis in the same position of the exposure position. Then the reticle stage 4 and the wafer stage 12 are driven based on the positional information on the previously-detected relative position of the reticle stage reference mark 3 to the reticle alignment mark 6, and the relative position of the chuck mark 8 to the wafer alignment mark 9, thereby the reticle 5 and the wafer 10 are aligned with each other in a desired position.

[0093] Thereafter, in a status where the plate and the substrate are aligned with each other, an exposure controller (not shown) emits exposure light from the light source, thereby the plate pattern is exposure-transferred onto the substrate. Note that the exposure light is EUV light having a wavelength of about 10 to 15 nm.

[0094] By this method, position detection for alignment and exposure are performed in parallel, and the limitation on the alignment detection optical system and projection optical system can be omitted in many cases. Thus, various alignment detection optical systems can be constructed, and high throughput with stable detection rate and high precision can be realized for various wafer processes.

[0095] Further, as the on-axis TTL alignment optical system is employed as the detection optical system for detection of the relative position of the reticle stage reference mark 3 to the chuck mark 8 in the exposure apparatus, there is no baseline, and the factor of degradation of detection precision can be eliminated.

(Embodiment of Semiconductor Production System)

[0096] Next, an example of semiconductor device (semiconductor chip of IC, LSI or the like, a liquid crystal panel, a CCD, a thin film magnetic head, a micromachine etc.) production system using the apparatus of the present invention will be described. The system performs maintenance services such as trouble shooting, periodical maintenance or software delivery for fabrication apparatuses installed in a semiconductor manufacturing factory, by utilizing a computer network outside the fabrication factory.

[0097] Fig. 7 shows the entire system cut out from an

angle. In the figure, numeral 101 denotes the office of a vendor (apparatus maker) of semiconductor device fabrication apparatuses. As the semiconductor fabrication apparatuses, apparatuses in the semiconductor fabrication factory for various processes such as preprocess apparatuses (lithography apparatuses including an exposure apparatus, a resist processing apparatus and an etching apparatus, a heat processing apparatus, a film forming apparatus, a smoothing apparatus and the like) and postprocess apparatuses (an assembly apparatus, an inspection apparatus and the like) are used. The office 101 has a host management system 108 to provide a maintenance database for the fabrication apparatus, plural operation terminal computers 110, and a local area network (LAN) 109 connecting them to construct an Intranet or the like. The host management system 108 has a gateway for connection between the LAN 109 and the Internet 105 as an external network and a security function to limit access from the outside.

[0098] On the other hand, numerals 102 to 104 denote fabrication factories of semiconductor makers as users of the fabrication apparatuses. The fabrication factories 102 to 104 may belong to different makers or may belong to the same maker (e.g., preprocess factories and postprocess factories). The respective factories 102 to 104 are provided with plural fabrication apparatuses 106, a local area network (LAN) 111 connecting the apparatuses to construct an Intranet or the like, and a host management system 107 as a monitoring apparatus to monitor operating statuses of the respective fabrication apparatuses 106. The host management system 107 provided in the respective factories 102 to 104 has a gateway for connection between the LAN 111 and the Internet 105 as the external network. In this arrangement, the host management system 108 on the vendor side can be accessed from the LAN 111 in the respective factories via the Internet 105, and only limited user(s) can access the system by the security function of the host management system 108. More particularly, status information indicating the operating statuses of the respective fabrication apparatuses 106 (e.g. problem of fabrication apparatus having trouble) is notified from the factory side to the vendor side via the Internet 105, and maintenance information such as response information to the notification (e.g. information indicating measure against the trouble, or remedy software or data), latest software, help information and the like is received from the vendor side via the Internet. The data communication between the respective factories 102 to 104 and the vendor 101 and data communication in the LAN 111 of the respective factories are performed by using a general communication protocol (TCP/IP). Note that as the external network, a private-line network (ISDN or the like) with high security against access from outsiders may be used in place of the Internet.

[0099] Further, the host management system is not limited to that provided by the vendor, but a database constructed by the user may be provided on the external network, to provide the plural user factories with access to the database.

[0100] Fig. 8 is a conceptual diagram showing the entire system of the present embodiment cut out from another angle different from that in Fig. 7. In the above example, the plural user factories respectively having fabrication apparatuses and the management system of the apparatus vendor are connected via the external network, and data communication is performed for production management for the respective factories and transmission of information on at least one fabrication apparatus. In this example, a factory having fabrication apparatuses of plural vendors is connected with management systems of the respective vendors of the fabrication apparatuses via the external network, and data communication is performed for transmission of maintenance information for the respective fabrication apparatuses. In the figure, numeral 201 denotes a fabrication factory of fabrication apparatus user (semiconductor device maker). In the factory fabrication line, fabrication apparatuses for various processes, an exposure apparatus 202, a resist processing apparatus 203 and a film forming apparatus 204, are used. Note that Fig. 8 shows only the fabrication factory 201, however, actually plural factories construct the network. The respective apparatuses of the factory are connected with each other by a LAN 206 to construct an Intranet, and a host management system 205 performs operation management of the fabrication line.

[0101] On the other hand, the respective offices of vendors (apparatus makers), an exposure apparatus maker 210, a resist processing apparatus maker 220, a film forming apparatus maker 230 have host management systems 211, 221 and 231 for remote maintenance for the apparatuses, and as described above, the systems have the maintenance database and the gateway for connection to the external network. The host management system 205 for management of the respective apparatuses in the user fabrication factory is connected with the respective vendor management systems 211, 221 and 231 via the Internet or private-line network as an external network 200. In this system, if one of the fabrication apparatuses of the fabrication line has a trouble, the operation of the fabrication line is stopped. However, the trouble can be quickly removed by receiving the remote maintenance service from the vendor of the apparatus via the Internet 200, thus the stoppage of the fabrication line can be minimized.

[0102] The respective fabrication apparatuses installed in the semiconductor fabrication factory have a display, a network interface and a computer to execute network access software stored in a memory and device operation software. As a memory, an internal memory, a hard disk or a network file server may be used. The network access software, including a specialized or general web browser, provides a user interface screen image as shown in Fig. 9 on the display. An operator who manages the fabrication apparatuses in the factory

checks the screen image and inputs information of the fabrication apparatus, a model 401, a serial number 402, a trouble case name 403, a date of occurrence of trouble 404, an emergency level 405, a problem 406, a remedy 407 and a progress 408, into input fields on the screen image. The input information is transmitted to the maintenance database via the Internet, and appropriate maintenance information as a result is returned from the maintenance database and provided on the display. Further, the user interface provided by the web browser realizes hyper link functions 410 to 412 as shown in the figure, and the operator accesses more detailed information of the respective items, downloads latest version software to be used in the fabrication apparatus from a software library presented by the vendor, and downloads operation guidance (help information) for the operator's reference. The maintenance information provided from the maintenance database includes the information on the above-described present invention, and the software library provides latest version software to realize the present invention.

[0103] Next, a semiconductor device fabrication process utilizing the above-described production system will be described. Fig. 10 shows a flow of the entire semiconductor fabrication process. At step 1 (circuit designing), a circuit designing of the semiconductor device is performed. At step 2 (mask fabrication), a mask where the designed circuit pattern is formed is fabricated. On the other hand, at step 3 (wafer fabrication), a wafer is fabricated using silicon or the like. At step 4 (wafer process) called preprocess, the above mask and wafer are used. An actual circuit is formed on the wafer by lithography. At step 5 (assembly) called postprocess, a semiconductor chip is formed by using the wafer at step 4. The postprocess includes processing such as an assembly process (dicing and bonding) and a packaging process (chip sealing). At step 6 (inspection), inspections such as an operation test and a durability test are performed on the semiconductor device assembled at step 5. The semiconductor device is completed through these processes, and it is shipped (step 7). The preprocess and the postprocess are independently performed in specialized factories, and maintenance is made for these factories by the above-described remote maintenance system. Further, data communication is performed for production management and/or apparatus maintenance between the preprocess factory and the postprocess factory via the Internet or private-line network.

[0104] Fig. 11 shows a more detailed flow of the wafer process. At step 11 (oxidation), the surface of the wafer is oxidized. At step 12 (CVD), an insulating film is formed on the surface of the wafer. At step 13 (electrode formation), electrodes are formed by vapor deposition on the wafer. At step 14 (ion implantation), ions are injected into the wafer. At step 15 (resist processing), the wafer is coated with photoresist. At step 16 (exposure), the above-described exposure apparatus exposure-transfers the circuit pattern of the mask onto the wafer. At step 17 (development), the exposed wafer is developed. At step 18 (etching), portions other than the resist image are etched. At step 19 (resist stripping), the resist unnecessary after the etching is removed. These steps are repeated, thereby multiple circuit patterns are formed on the wafer. As maintenance is performed on the fabrication apparatuses used in the respective steps by the above-described remote maintenance system, trouble is prevented, and even if it occurs, quick recovery can be made. In comparison with the conventional art, the productivity of the semiconductor device can be improved.

[0105] As described above, according to the present embodiment, in an EUV exposure apparatus, for example, relative alignment between a plate and a substrate can be performed by using a plate stage reference mark in which high reflectivity can be comparatively easily set with respect to alignment illumination light and which provides positional reference of the plate stage and a chuck mark on a chuck as alignment marks. Thus alignment illumination light with high S/N ratio can be obtained. Especially, in a case where the present invention is applied to the TTL method, as on-axis TTL detection method is used in the off-axis detection, there is no so-called baseline. Accordingly, high precision alignment can be performed between a reticle or the like and a wafer or the like without expensive part.

[Other Embodiment]

[0106] The present invention includes a case where the object of the present invention can be also achieved by providing software program for performing the functions of the above-described embodiments to a system or an apparatus from a remote position, and reading and executing the program code with a computer of the system or apparatus. In such case, the form of the software is not necessary a program as long as it has a function of program.

[0107] Accordingly, to realize the functional processing of the present invention by the computer, the program code itself installed in the computer realizes the present invention. That is, the claims of the present invention include a computer program itself to realize the functional processing of the present invention.

[0108] In such case, other form of program such as a program executed by object code, interpreter and the like, or script data to be supplied to an OS (Operating System), as long as it has the function of program.

[0109] As a storage medium for providing the program, a floppy disk, a hard disk, an optical disk, a magnetooptical disk, an MO, a CD-ROM, a CD-R, a CD-RW, a magnetic tape, a non-volatile type memory card, a ROM, a DVD (a DVD-ROM and a DVD-R) or the like can be used.

[0110] Further, the program may be provided by accessing a home page on the Internet by using a browser

of a client computer, and downloading the computer program itself of the present invention or a compressed file having an automatic installation function from the home page to a storage medium such as a hard disk. Further, the present invention can be realized by dividing program code constructing the program of the present invention into plural files, and downloading the respective files from different home pages. That is, the claims of the present invention also include a WWW server holding the program file to realize the functional processing of the present invention to be downloaded to plural users.

[0111] Further, the functional processing of the present invention can be realized by encrypting the program of the present invention and storing the encrypted program into a storage medium such as a CD-ROM, delivering the storage medium to users, permitting a user who satisfied a predetermined condition to download key information for decryption from the home page via the Internet, and the user's executing the program by using the key information and installing the program into the computer.

[0112] Furthermore, besides the functions according to the above embodiments are realized by executing the read program by a computer, the present invention includes a case where an OS or the like working on the computer performs a part or entire actual processing in accordance with designations of the program code and realizes functions according to the above embodiments.

[0113] Furthermore, the present invention also includes a case where, after the program code read from the storage medium is written in a function expansion board which is inserted into the computer or in a memory provided in a function expansion unit which is connected to the computer, CPU or the like contained in the function expansion board or unit performs a part or entire process in accordance with designations of the program code and realizes functions of the above embodiments.

[0114] The illustrated embodiment permits a TTL (i.e. through the reflective optical system used for exposure) alignment operation to be carried out using light within 5nm, preferably within 1nm, more preferably within 0.5nm of the wavelength of the exposure light. This enables high-precision alignment, because the aberration of the optical system can be reduced. This alignment light wavelength close to the exposure light wavelength gives a high reflection rate. It is possible because the TTL alignment operation uses marks on means which holds the wafer and on means which holds the reticle.

[0115] The present invention is not limited to the above embodiments and various changes and modifications can be made within the spirit and scope of the present invention.

Claims

1. A position detection method for detecting positions of a reflective type plate and a substrate upon exposure-transfer of pattern on said plate onto said substrate by emitting non-exposure light to said plate and said substrate and receiving reflected light from said plate and said substrate, **characterized by** comprising the steps of:

   a first position detection step of detecting a plate holding unit mark, being provided on a plate holding unit movable while holding said plate and having a predetermined reflection characteristic to said non-exposure light, and a substrate holding unit mark, being provided on a substrate holding unit movable while holding said substrate and having a predetermined reflection characteristic to said non-exposure light; and
   a relative position detection step of detecting a relative position of said plate to said substrate from relative position of said plate holding unit mark to said substrate holding unit mark.

2. The position detection method according to claim 1, **characterized in that** a plate alignment mark is provided on said plate, and wherein said method further comprises a second position detection step of detecting a relative position of said plate holding unit mark to said plate alignment mark.

3. The position detection method according to claim 1 or 2, **characterized in that** a substrate alignment mark is provided on said substrate, and wherein said method further comprises a third position detection step of detecting a relative position of said substrate holding unit mark to said substrate alignment mark.

4. The position detection method according to any one of claims 1 to 3, **characterized in that** at said first position detection step, said substrate holding unit mark is detected on-axis in the same position as an exposure position, and at said relative position detection step, relative alignment is made between said plate and said substrate by using positional information of said substrate holding unit mark.

5. The position detection method according to any one of claims 1 to 4, **characterized in that** said non-exposure light is extreme ultra violet light having a wavelength of 10 to 15 nm, and wherein said predetermined reflection characteristic is a reflectivity to said non-exposure light set to 95% or higher.

6. The position detection method according to any one of claims 1 to 5, **characterized in that** said reflective type plate has a reflection portion of multilayer structure.

7. The position detection method according to any one of claims 1 to 6, **characterized in that** said substrate holding unit has a substrate chuck holding said substrate, and wherein said substrate holding unit mark is provided on said substrate chuck.

8. The position detection method according to any one of claims 1 to 7, **characterized in that** at said first position detection step, said plate holding unit mark and said substrate holding unit mark are detected upon each exposure.

9. A position detection apparatus for detecting positions of reflective type plate and a substrate upon exposure-transfer of pattern on said plate onto said substrate by emitting non-exposure light to said plate and said substrate and receiving reflected light from said plate and said substrate, **characterized by** comprising:

   a first position detection unit that detects a plate holding unit mark, being provided on a plate holding unit movable while holding said plate and having a predetermined reflection characteristic to said non-exposure light, and a substrate holding unit mark, being provided on a substrate holding unit movable while holding said substrate and having a predetermined reflection characteristic to said non-exposure light; and
   a relative position detection unit that detects a relative position of said plate to said substrate from relative position of said plate holding unit mark to said substrate holding unit mark.

10. The position detection apparatus according to claim 9, **characterized in that** a plate alignment mark is provided on said plate, and wherein said apparatus further comprises a second position detection unit that detects a relative position of said plate holding unit mark to said plate alignment mark.

11. The position detection apparatus according to claim 9 or 10, **characterized in that** a substrate alignment mark is provided on said substrate, and wherein said apparatus further comprises a third position detection unit that detects a relative position of said substrate holding unit mark to said substrate alignment mark.

12. The position detection apparatus according to any one of claims 9 to 11, **characterized in that** said first position detection units detects said substrate holding unit mark on-axis in the same position as an exposure position, and said relative position detection unit performs relative alignment between said plate and said substrate by using positional information of said substrate holding unit mark.

13. The position detection apparatus according to any one of claims 9 to 12, **characterized in that** said non-exposure light is extreme ultra violet light having a wavelength of 10 to 15 nm, and wherein said predetermined reflection characteristic is reflectivity to said non-exposure light set to 95% or higher.

14. The position detection apparatus according to any one of claims 9 to 13, **characterized in that** said reflective type plate has a reflection portion of multilayer structure.

15. The position detection apparatus according to any one of claims 9 to 14, **characterized in that** said substrate holding unit has a substrate chuck holding said substrate, and wherein said substrate holding unit mark is provided on said substrate chuck.

16. The position detection apparatus according to any one of claims 9 to 15, **characterized in that** said first position detection unit detects said plate holding unit mark and said substrate holding unit mark upon each exposure.

17. An exposure method for performing alignment between a plate and a substrate based on the relative position of said plate to said substrate detected by the position detection method according to any one of claims 1 to 8, and exposure-transferring a pattern on said plate onto said substrate.

18. An exposure apparatus **characterized by** comprising:

   the position detection apparatus according to any one of claims 9 to 16;
   a moving control unit that performs alignment between said plate and said substrate by move-controlling said plate holding unit and said substrate holding unit based on a relative position of said plate to said substrate detected by said position detection apparatus; and
   an exposure control unit that exposure-transfers the pattern on said plate onto said substrate in a status where said plate and said substrate are aligned with each other.

19. A semiconductor device fabrication method **characterized by** comprising:

   a step of installing a fabrication apparatus group for various processes including the exposure apparatus according to claim 18 in a semiconductor fabrication factory; and
   a step of fabricating a semiconductor device by plural processes by using said fabrication apparatus group.

20. The semiconductor device fabrication method according to claim 19 further comprising:

a step of connecting said fabrication apparatus group by a local area network; and
a step of performing data communication for transmission of information on at least one apparatus of said fabrication apparatus group between said local area network and an external network outside said semiconductor fabrication factory.

21. The semiconductor device fabrication method according to claim 20, **characterized in that** maintenance information for said fabrication apparatus is obtained by accessing a database provided by a vendor or a user of said exposure apparatus via said external network, or production management is performed by data communication with other semiconductor fabrication factory than said semiconductor fabrication factory via said external network.

22. A semiconductor fabrication factory having:

a fabrication apparatus group including the exposure apparatus according to claim 18;
a local area network connected to said fabrication apparatus group; and
a gateway that enables access from said local area network to an external network outside said a factory,

characterized in that data communication is performed for transmission of information on at least one apparatus of said fabrication apparatus group.

23. An exposure apparatus maintenance method for maintenance of the exposure apparatus according to claim 18 installed in a semiconductor fabrication factory, comprising:

a step of providing a maintenance database connected to an external network outside the semiconductor fabrication factory by a vendor or user of said exposure apparatus;
a step of permitting access to said maintenance database from said semiconductor fabrication factory via said external network; and
a step of transmitting maintenance information stored in said maintenance database to the side of said semiconductor fabrication factory via said external network.

24. The exposure apparatus according to claim 18, further comprising a display, a network interface and a computer that executes network software, wherein maintenance information for said exposure apparatus is transmitted via a computer network.

25. The exposure apparatus according to claim 24, **characterized in that** said network software provides a user interface on said display to access a maintenance database, provided by a vendor or user of said exposure apparatus, connected to an external network outside the factory having said exposure apparatus, and obtains information from said database via said external network.

26. Exposure apparatus for exposing a substrate (10) with a pattern provided in a reflective manner on a pattern carrier (5), the apparatus comprising:

a source of exposure light for illuminating the pattern on the pattern carrier;
a reflective optical system (7) for transmitting exposure light from the pattern carrier to the substrate, to form an image of the pattern on the substrate;
a carrier holder (4) for holding the pattern carrier (5); and
a substrate holder (11) for holding the substrate (10),

characterised by:

first alignment means (1,2) for detecting the relative alignment between the carrier holder (4) and the substrate holder (11) by exposing them to alignment light and reflecting the alignment light from one of them to the other through the said reflective optical system;
second alignment means (30,31,40,41) for detecting the relative alignment between the pattern carrier (5) and the carrier holder (4) and the relative alignment between the substrate (10) and the substrate holder (11); and
determining means for determining the alignment between the pattern carrier (5) and the substrate (10) from the outputs of the first and second alignment means.

27. Apparatus according to claim 26 in which the first alignment means (1,2) is arranged to detect the relative alignment between the carrier holder (4) and the substrate holder (11) when the carrier holder (4) and the substrate holder (11) are in respective exposure positions for exposing a substrate held on the substrate holder (11) with a pattern carried by a pattern carrier held on the carrier holder (4) using exposure light from the said source and transmitted through the said reflective optical system (7).

28. Apparatus according to claim 27 in which the second alignment means comprises means to move at

least one of the said holders (4,11) between its respective exposure position and a respective alignment location and means to detect the relative alignment between the said at least one holder and the pattern carrier or substrate held by it while it is at its alignment location.

FIG. 1

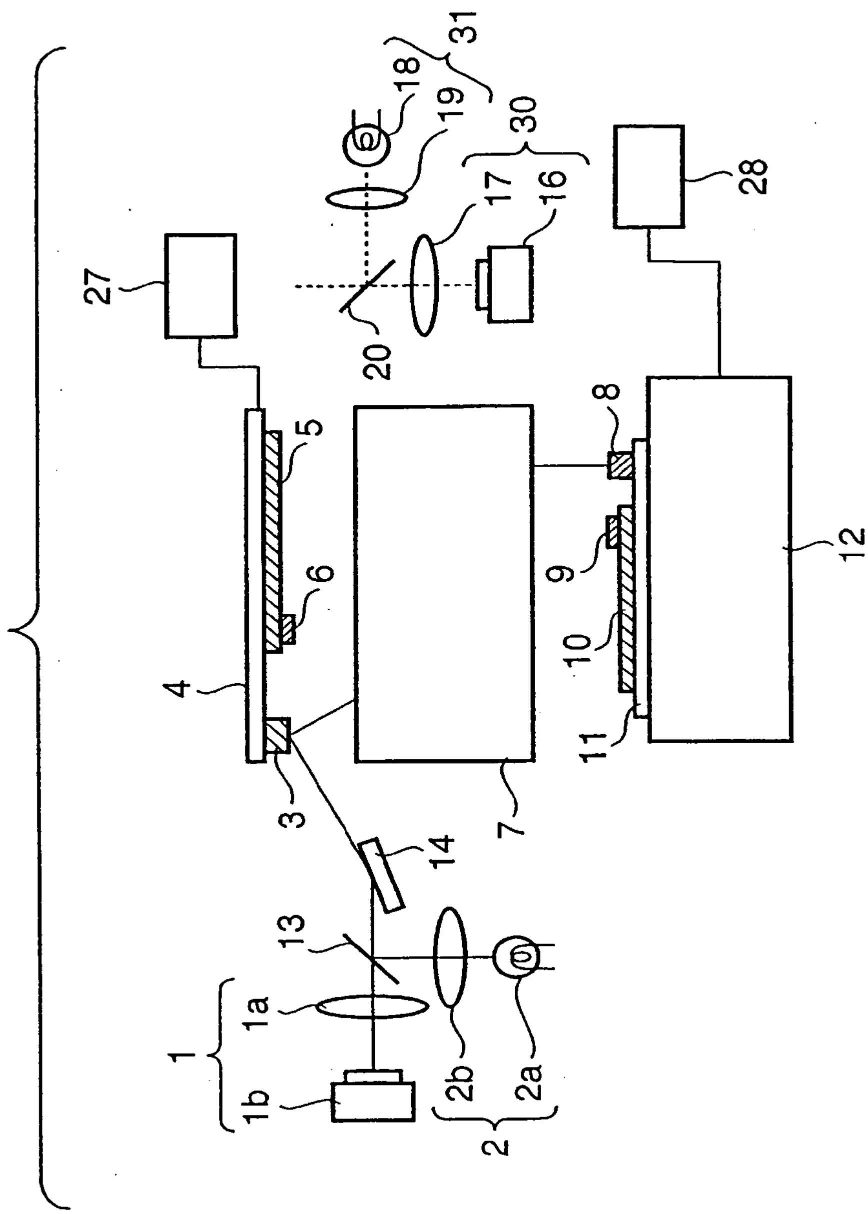

FIG. 2

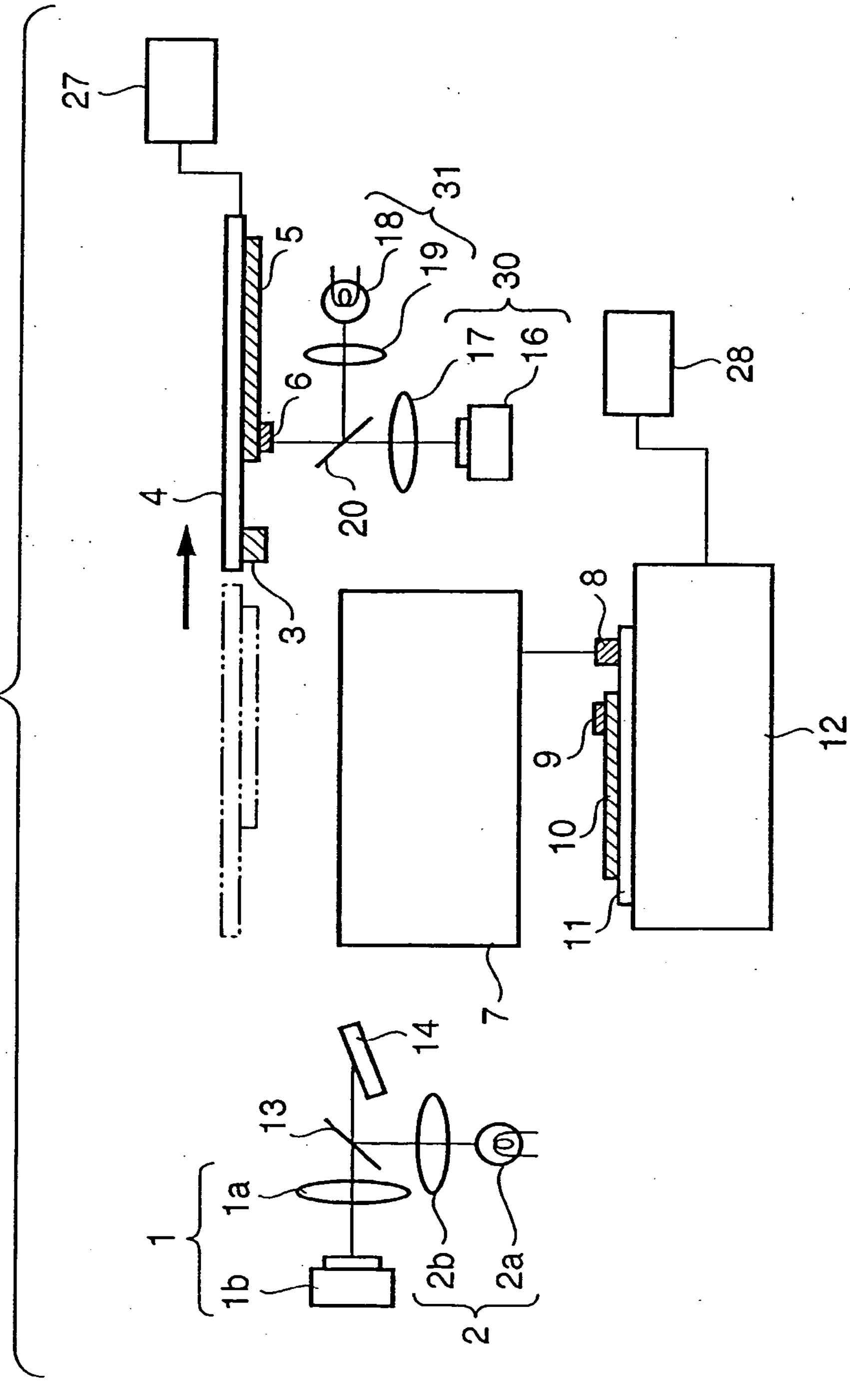

FIG. 3

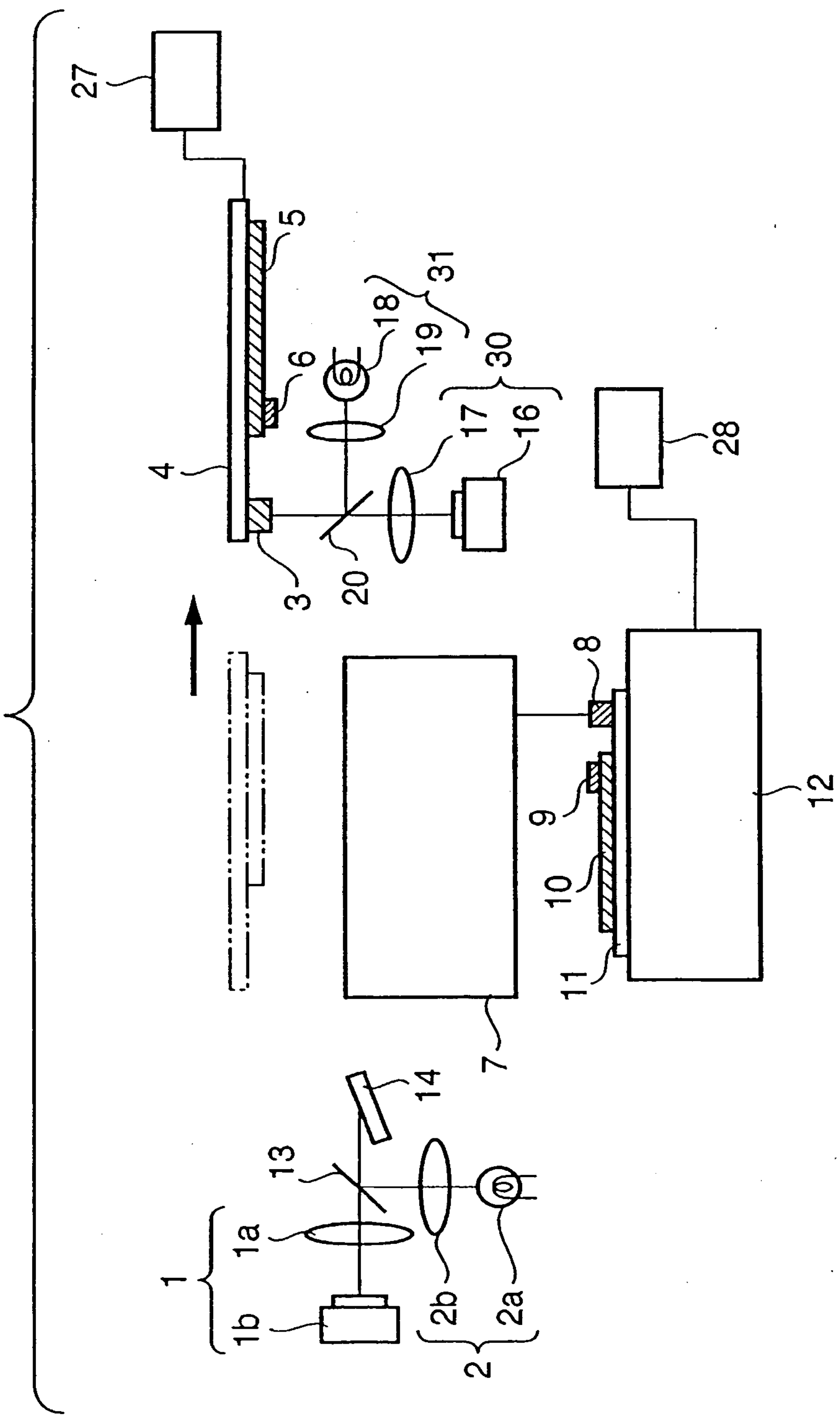

FIG. 4

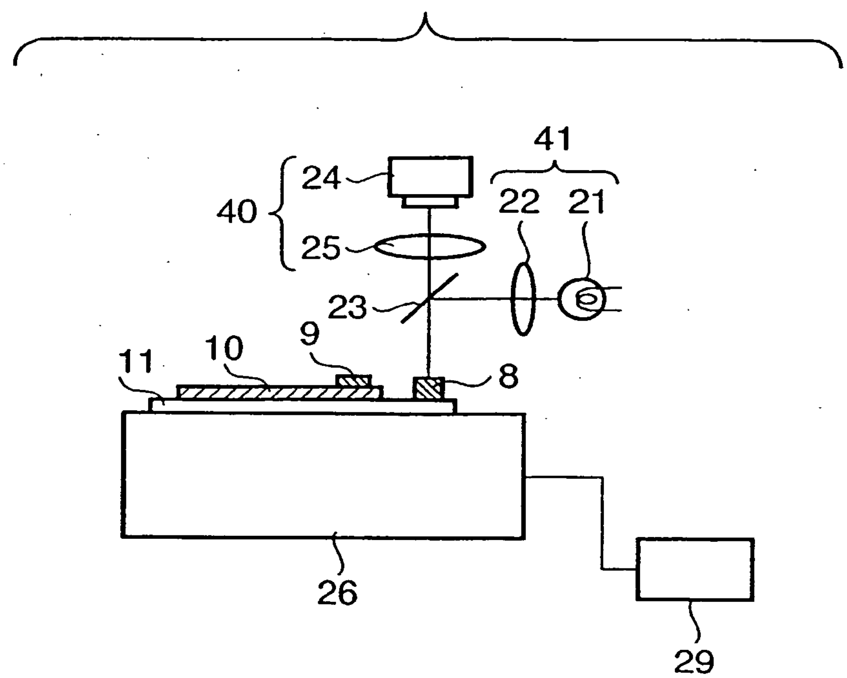

FIG. 5

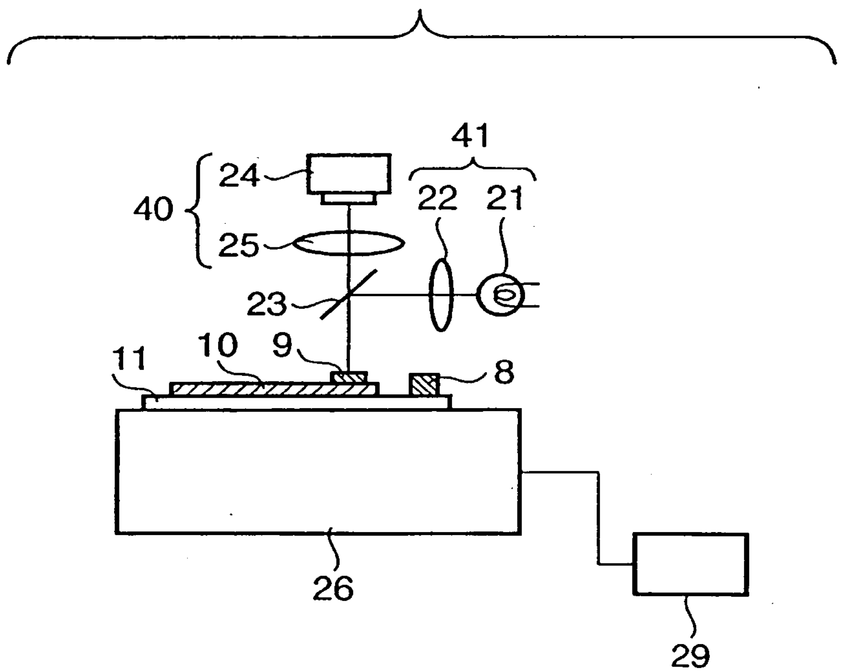

FIG. 6

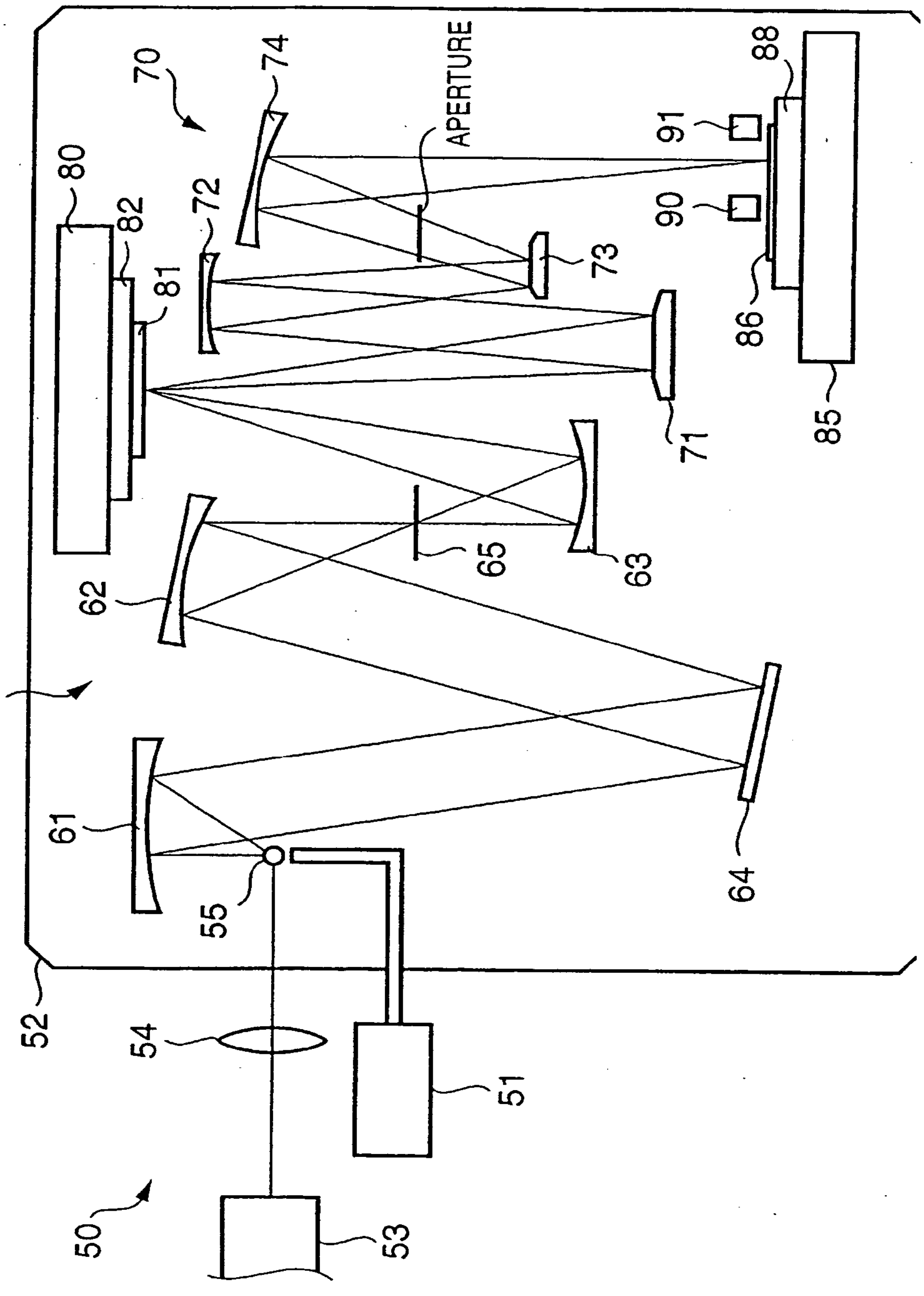
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FIG. 7

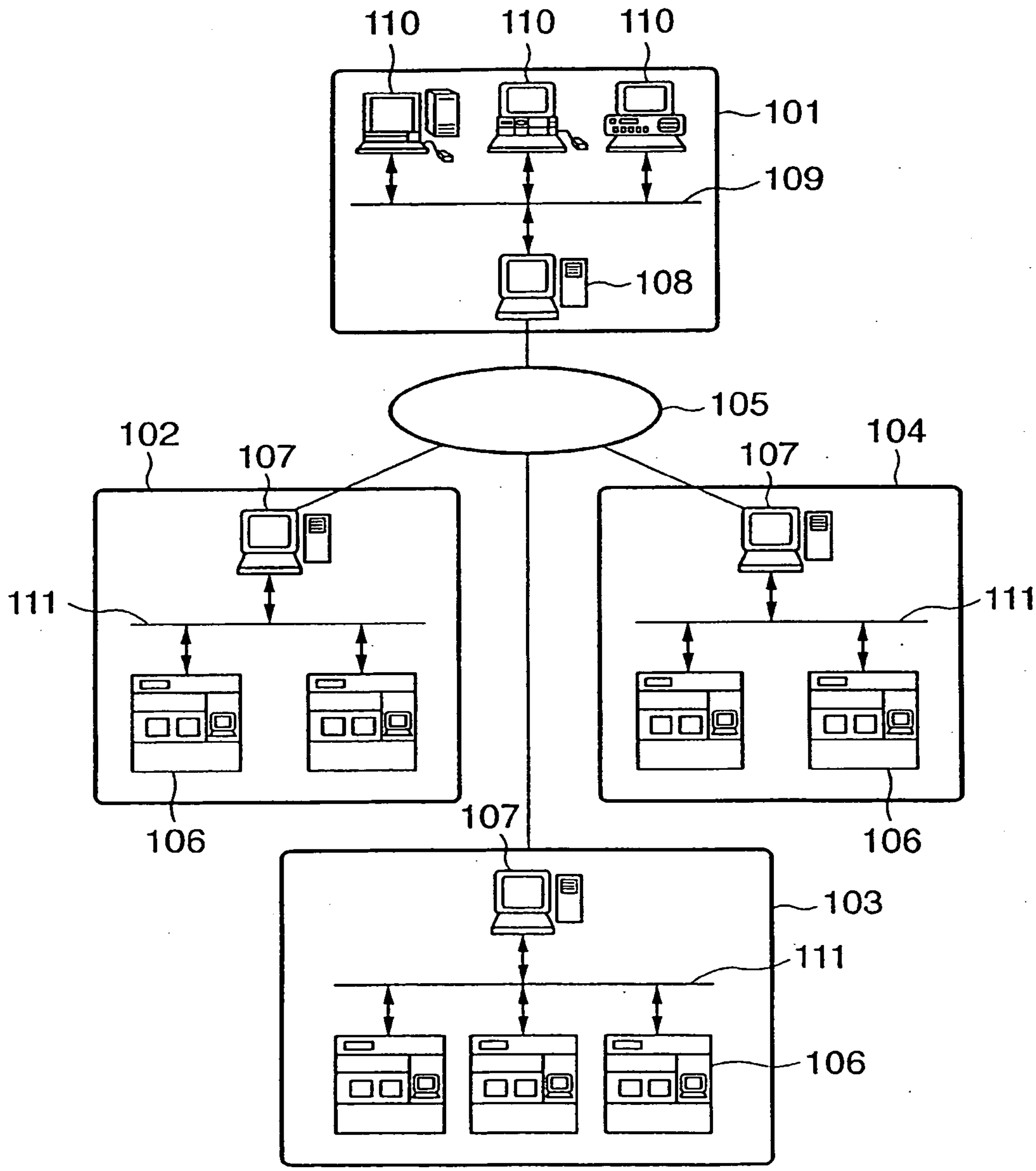
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FIG. 8

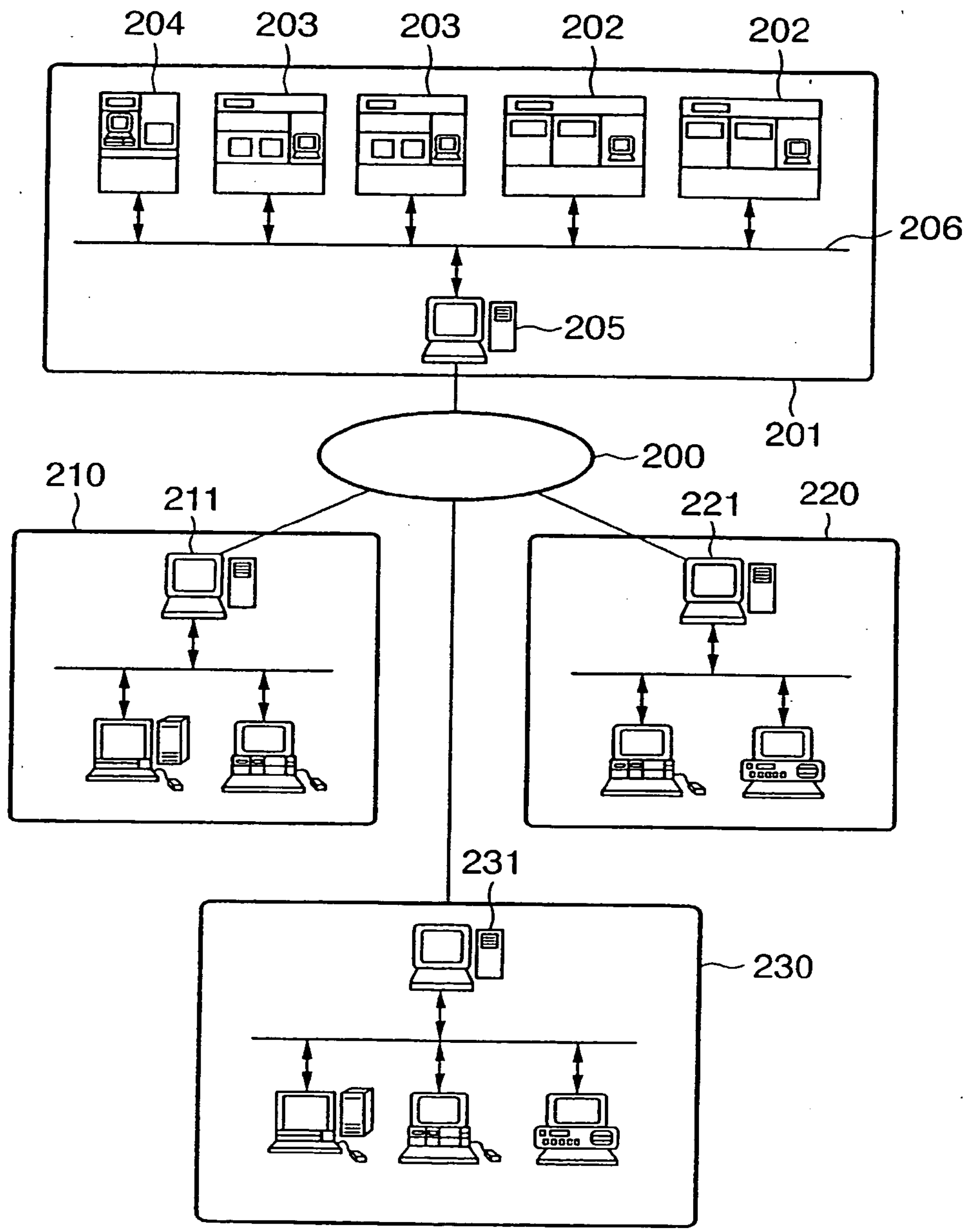
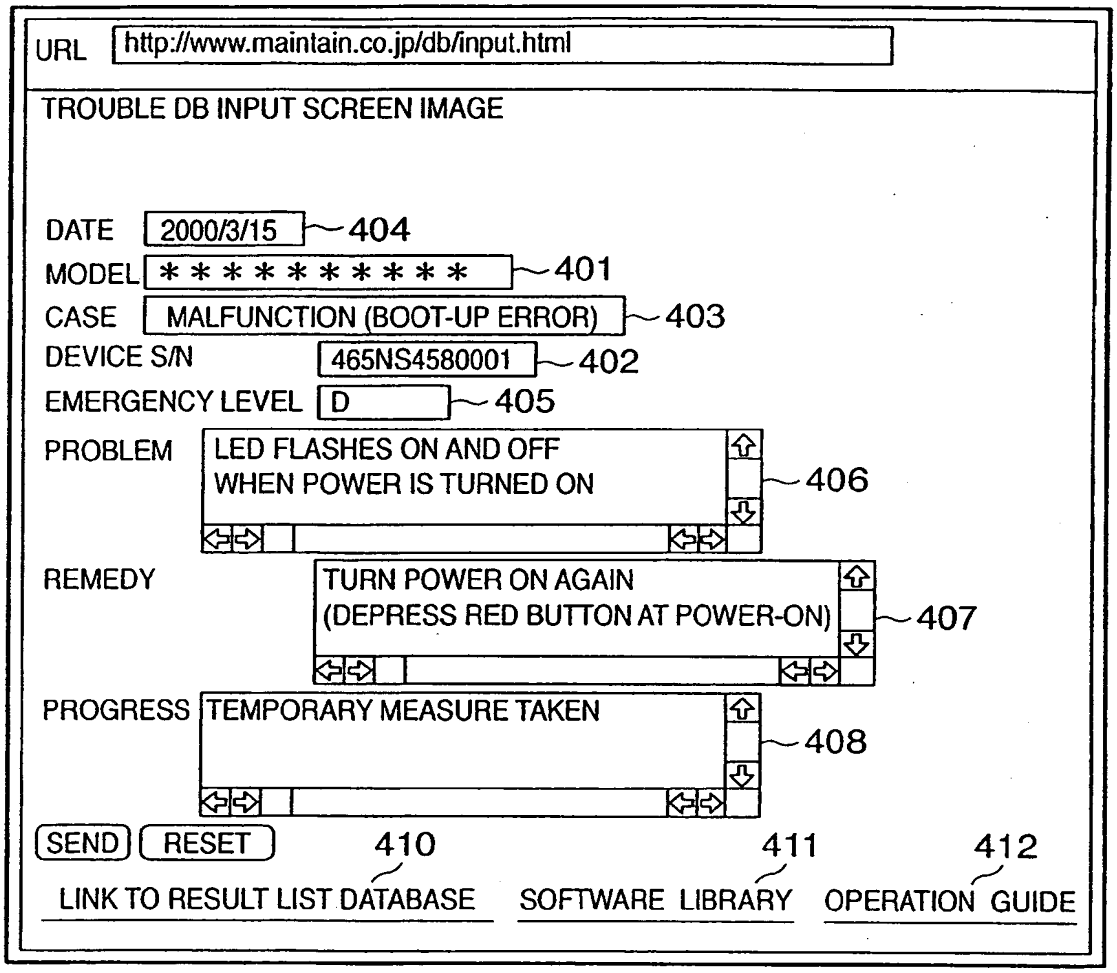


FIG. 9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PROBLEM
LED FLASHES ON AND OFF
WHEN POWER IS TURNED ON
406
REMEDY
TURN POWER ON AGAIN
(DEPRESS RED BUTTON AT POWER-ON)
407
PROGRESS
TEMPORARY MEASURE TAKEN
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SEND
RESET
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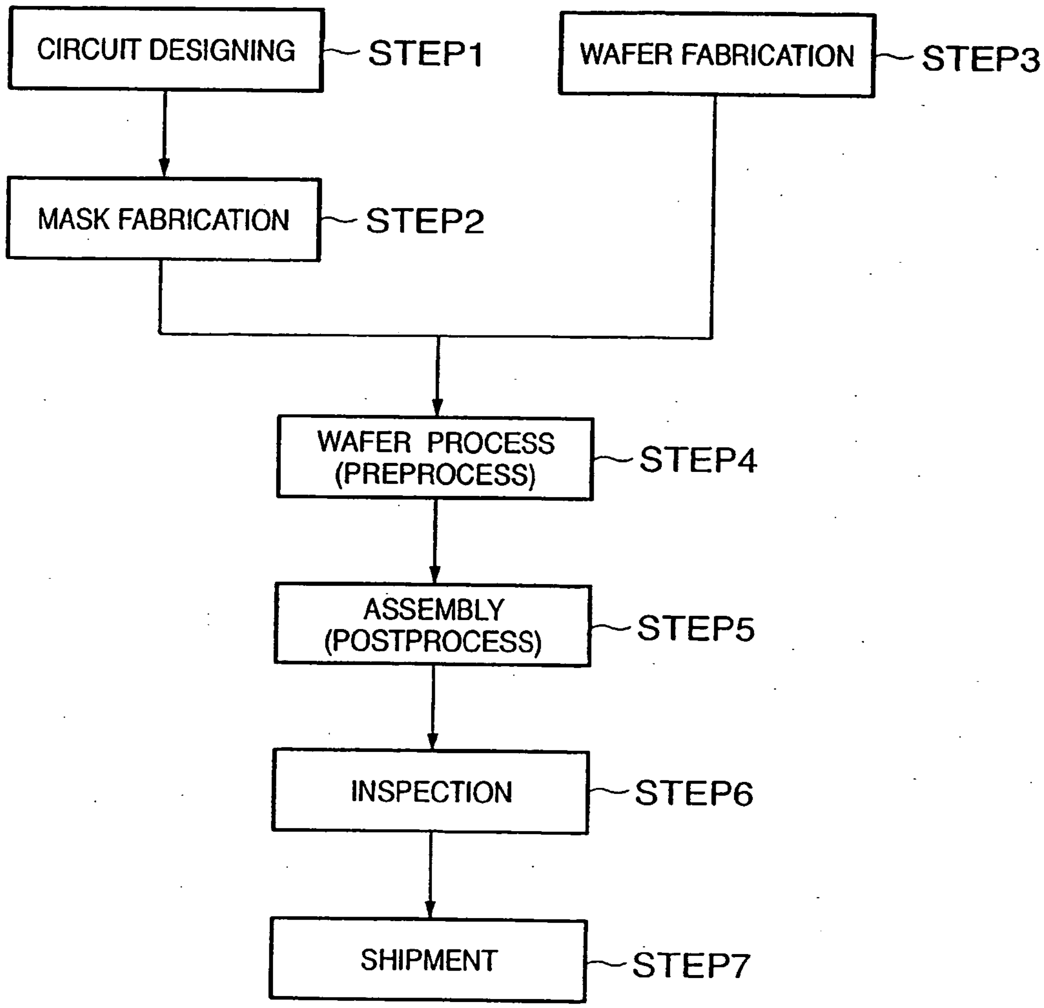
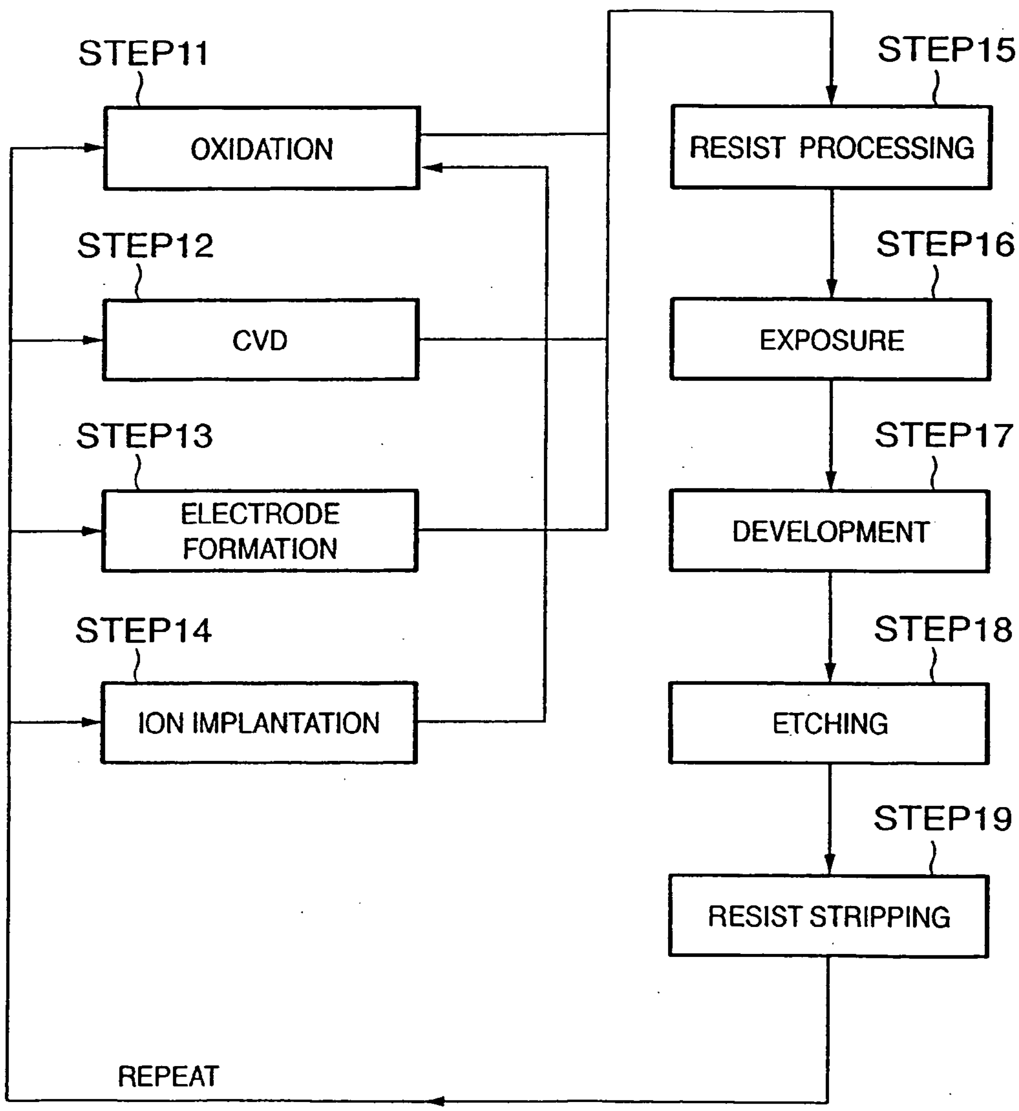
LINK TO RESULT LIST DATABASE
SOFTWARE LIBRARY
OPERATION GUIDE

FIG. 10



SEMICONDUCTOR DEVICE FABRICATION FLOW

F I G. 11



WAFER PROCESS